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Effect of a virtual project team environment on communication-related project risk

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Abstract

Over 150 Information Technology practitioners participated in a study of differences in communication risk between traditional project teams and those that operate virtually, with some team members physically remote. Contrary to prior research, results indicate the level of risk from inadequate communication is not significantly greater when team members are not grouped in one location. Further, despite increased dependence of virtual teams on technology for communication, there was no evidence of significantly more project risk due to technological failure. However, virtual team projects exhibited notably more risk due to insufficient knowledge transfer. A plausible explanation is decreased implicit or informal knowledge transfer in virtual environments. We conclude that the possibility of insufficient knowledge transfer should be included in virtual project risk management plans, and consideration should be given in such projects to the extent to which knowledge that is traditionally shared implicitly might be shared explicitly through electronic means.

Keywords: Virtual teams; Virtual projects; Risk management; Project management; Communication; Co-located teams; Knowledge transfer; Implicit knowledge

1. Introduction

This research addresses an area where little prior research has been done, communication-related risk on virtual team projects. Virtual project teams have been defined as groups of people who are not co-located, using electronic communication to work together to accomplish a goal (Jones et al., 2005). Team members can be located in different cities, states and increasingly in different countries. An example of a virtual project team, as described by a study participant, was a team that resided in both the United States and India working on a project to create a customized website integrated with an ERP system.

Project teams composed of members from different countries are becoming common place (Klie, 2007). This increase is due to the global nature of business, outsourcing, off shoring, availability of high-bandwidth communications, and reduced business travel due to cost and security concerns (Aspray et al., 2006). Foreign competition for talent has played a role in the global nature of virtual teams also. This current prevalence of virtual teams raises questions about differences that may exist between virtual software project teams and traditional co-located software project teams. One such area of potential difference is the degree of impact caused by various project risk factors, and in particular, communication-related risk factors.

Managing risks on projects is important to project success and often falls under the domain of the project manager, as indicated by Olsson (2007), who states that risk management has become "an integral part of project management". DeMarco and Lister (2003) describe the close relationship between risk and problems, "risk is a problem

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that has yet to occur, and a problem is a risk that has already materialized" (DeMarco and Lister, 2003). This relationship between a risk and a problem suggests a link between project risk and project failure. Unmitigated risks that escalate into problems can result in effects ranging from unmet user requirements and performance issues to loss of dollars and lost opportunities, not to mention complete project failure (Boehm, 1991; Wallace and Keil, 2004).

The negative impact of software project risk has been measured for years by the Standish Group. Their CHAOS survey and report has shown overall from 1996 to 2006 the percentage of challenged and cancelled projects has decreased slightly, by between 3% and 13% while the percentage of successful projects overall increased by 1% to as much as 6% (Standish Group, 1999, 2001, 2004, 2006). These numbers support perceptions of the continuing existence of project problems and failures, whose general prevention is the goal of project management.

Identification and knowledge of project risk factors has been cited as a method of decreasing the severity and the impact of risk (Boehm, 1991). Consequently, multiple researchers in project management created lists of top project risks on software projects (Boehm, 1991; Barki et al., 1993; Keil, 1998; Wallace and Keil, 2004). One of the original lists was created by Boehm (1991) and consisted of the "top ten software risk items": personnel shortfalls, unrealistic schedules and budgets, developing the wrong functions and properties, developing the wrong user interface, gold-plating, continuing stream of requirements changes, shortfalls in externally furnished components, shortfalls in externally performed tasks, real-time performance shortfalls, and straining computer-science capabilities. By and large, these prior project risk studies were conducted at a time when projects involved traditional, co-located teams. By comparison, little is known about risks on virtual projects.

This paper investigates the risk management aspects of project management by exploring the differences on virtual versus co-located software project teams for some specific communication-related risks, an area of risk identified by Wallace (1999). We report here on the communication risk portion of a larger research study. The main purpose of this manuscript is to address the following research question: What, if any, are the significant differences in communication-related risk between virtual and co-located Information Technology projects?

Three specific project risk factors relating to communication were distilled from past research, along with a combination of focus groups and pilot studies. Note that the focus group and pilot studies are described later in the methodology section.

2. Communication-related risk factors

It is not uncommon to find communication issues on projects. Lee-Kelley and Sankey (2008) indicated in their research that time zone and cultural differences affected communications as well as team relations on projects (Lee-Kelley and Sankey, 2008). During the face-to-face interview portion of this research study, a project manager commented on the difficulty in communicating with remote resources, "It is more difficult to communicate over the phone than to walk over to the person's desk to talk." This same project manager indicated problems occurred when team members resided on different LANs, making it difficult to exchange documents. Overall these communications issues cited by the interviewee were overcome by creating extra steps in the process which then "translated into loss of time." Focus group participants in the study also elaborated on communication issues they encountered on their projects. Some of their comments are as follows:

- Particularly in large projects, communication is essential for efficient coordination.
- Lack of communication can lead to people "not being on the same page" and "working at cross purposes".
- Lack of communication can lead to confusion that can add more cost and more time.
- Having good communication with your client and group members is very important when working on any project.
- False starts from misunderstandings are expensive in terms of time and resources and they also create bad feeling within a team.
- Meeting overload is also a risk; projects that meet too much and work too little also suffer from poor morale.

Information collected through the literature review, from face-to-face interviews and the focus group was distilled into three communication-related risk factors that were included in the survey. Each of these three risk factors is described next.

2.1. Lack of or inadequate communication

The first communication-related risk factor that emerged from this study is *Lack of or inadequate communication*. This risk factor is defined by a low level of communication frequency with project team members or communication at the wrong level of detail for the audience. For example, a project dealing with familiar processes and well known work might require a low level of communication frequency since team members are experienced. On the other hand, innovative or technically challenging projects might need a high level of communication frequency to deal with many unknowns. Effective communication has been identified as the most critical component of teamwork (Jones et al., 2005). Wallace and Keil (2004) in their research on outsourced projects, which sometimes can be classified as a type of virtual project, indicated team risk may be due to greater challenges in team communication and coordination, especially when at least two organizations were involved (Wallace and Keil, 2004). Examples of communication at the wrong level of detail for the audience include upper

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management receiving minute details while project team members are only provided a broad overview of project information. In addition to prior research, this risk factor also was identified from face-to-face interviews and a focus group, as detailed in the methodology section. All these sources led to our first hypothesis:

H1: Lack of or inadequate communication will be a significantly greater risk for projects using virtual teams than for those employing traditional co-located teams.

2.2. Technical connectivity issues that hinder communication

The second communication-related risk factor, *Technical connectivity issues hinder communication,* focuses on technical issues with the communication tools used by virtual teams. Since virtual teams are dependent on electronic communication, any down time could effectively isolate members of the team and halt the flow of work. Such technologies as web conferencing, instant messaging, document sharing sites, and the like can be important in providing a rich communication environment for team members who cannot have face-to-face encounters. This risk factor was identified from face-to-face interviews and a focus group, as detailed in the methodology section, and led to our second hypothesis:

H2: Technical connectivity problems will be a significantly greater risk for projects using virtual teams than for those employing traditional co-located teams.

2.3. Insufficient knowledge transfer

The third communication-related risk factor, *Insufficient knowledge transfer,* refers to a more complex aspect of communication. Knowledge transfer is defined as the "unidirectional exchange" of knowledge, generally with a clear objective and geared toward a specific recipient (King, 2006). However, knowledge transfer is much more complex than the definition indicates. There are two distinct methods of knowledge transfer, explicit and implicit. Explicit transfer of knowledge is more formal and uses methods such as documentation, training and interviews. Implicit transfer of knowledge is very informal and involves methods such as storytelling, mentoring or coaching, and communities of practice (DeLong, 2004). Wallace (1999) identified this risk as an important part of "team" risk dimensions in her research on traditional software project risk (Wallace, 1999). This prior research, coupled with the results of our face-to-face interviews and focus groups, led to our third and final communication-related hypothesis:

H3: Insufficient knowledge transfer will pose a significantly greater risk for projects using virtual teams than for those employing traditional co-located teams.

3. Research method

The research method involved several steps beginning with a review of past literature on risk factors to create a list of common project risks. This step was followed by face-to-face interviews of IT project managers who were asked open-ended questions to encourage them to describe risks they encountered on virtual and traditional software projects. A list of risk factors was then composed, including factors mentioned in the literature along with those noted in the face-to-face interviews. A focus group of IT practitioners (project leaders/managers, team leads, systems analysts and project team members) was then used to validate the list, adding additional risks from a practitioner's point of view. The resulting massive list of risk factors was sorted and combined using a card-sorting technique to create a concise list of fifty-five risk factors that formed the basis for the final survey questions. Three of these risk factors centered on communication (lack of communication, technical connectivity issues that hinder communication, and insufficient knowledge transfer), and were described in detail earlier in this report.

An online questionnaire was used to survey of over 150 experienced IT industry practitioners, (i.e. project managers and project analysts) and was conducted to identify the degree of impact specific risk factors had on the successful completion of software development projects. Participants were asked to focus on a recent specific virtual software project on which to base their answers. Those who had not participated in a recent virtual software project were asked to answer based on a recent co-located software project. Survey participants were asked to respond to each risk factor using a three-point Likert scale to indicate the degree of impact each risk factor had on the successful completion of their specific project. In the three-point Likert scale the possible selections were "major impact", "minor impact" or "no impact/did not occur".

Some general survey demographics are shared in Table 1 to provide a better understanding of the varied nature of the participant and project backgrounds.

Overall, about two-thirds of the projects on which the survey was based were virtual software development projects. A majority of the projects were new development types (48%) with costs ranging from $100K to $1M. Most of the projects were short-term with the duration of a majority of the projects (53%) under 1 year. The majority of the teams were large with 36% of them having more than 20 team members. All study participants were located in the United States. Participants were asked to report on the number of non-English speaking locations. 51% indicated project team locations were a mix of English and non-English speaking while 5% indicated all locations were non-English speaking. Participants were generally project management practitioners with the majority (65%) being IT project managers with a wide variety of experience levels. Most other participant roles were team leads, systems

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Table 1
Basic demographic information.

Project environment (%)	
Virtual projects	69
Co-located projects	31
Project type (%)	
New development	48
Package installation	18
Software upgrade	23
Other	11
Project cost (%)	
<$100K	22
>$100K to $1M	40
>$1M	33
Project duration (%)	
<1 year	53
1–2 years	27
>2 years	20
Project team size (%)	
1–5 people	10
6–10 people	28
11–15 people	17
16–20 people	9
>20 people	36
Industry (most common) (%)	
IT services	14
Finance/banking	13
Manufacturing	13
Business consulting	8
Project manager experience (%)	
<5 years	25
5–10 years	35
>10 years	31
Not the project Mgr	9
Study participant's role on the project (%)	
Project manager/leader	65
Team lead	19
Team member	5
Other	11
Project team locations (%)	
English and non-English locations	51
All English locations	44
All non-English locations	5

analysts and project team members. End users were not included in the survey participant group. The projects were based in companies from a wide variety of industries.

4. Results and discussion

The three communication-related risk factors from the survey questionnaire are listed in Table 2. Chi-square statistics were used to compare and contrast the risk factors and *p*-values were used to determine significant differences. Also included in the table are the participant response percentages for each of these three risk factors.

The participant response percentages to the first communication-related risk factor indicated the risk of *Lack of or inadequate communication* had an important impact on the successful completion of both virtual and co-located projects. Almost half (48%) of virtual project participants and 40% of co-located project participants indicated this type of risk had a major impact on their project. About a third (35%) of virtual project participants and 36% of co-located project participants felt this risk caused a minor impact. Additionally, this risk factor scored the highest on major impact of all fifty-five risk factors in the survey. These results are understandable and are in line with other literature that indicates communication is an important risk on a project (Pare and Dube, 1999). What is surprising is the insignificant difference between virtual and co-located projects, indicated by a *p*-value well over 0.05 (0.6267).

The results refute our original hypothesis, H1, that there would be significant differences between virtual and co-located software projects for this communication-related risk factor. It appears lack of communication or inadequate communication is a key risk on many projects, regardless of the proximity of the team members. Perhaps significant differences between the two types of teams were not found because electronic media have provided new methods of communication and new models for project team communications, through the use of Web conferencing, instant messaging, email, texting, document sharing sites, blogs, wikis, social networks, and the like. This variety of communication tools and methods might be exploited to improve communication on projects regardless of the environment, virtual or co-located. A recent case study indicated there was a possibility that once they become used to working virtually, virtual team members may not need to communicate orally (Lee-Kelley and Sankey, 2008).

The participant response percentages to the second communication-related risk factor indicated *Technical connectivity*

Table 2
Communication-related risk factor survey response percentages.

Risk factors	Virtual projects			Co-located projects			*p*-value
	No impact or did not occur	Minor impact	Major impact	No impact or did not occur	Minor impact	Major impact	
Lack of or inadequate communication	17.76	34.58	47.66	23.40	36.17	40.43	0.6267
Technical connectivity issues hinder communication	31.78	53.27	14.95	34.04	48.94	17.02	0.8783
Insufficient knowledge transfer	31.78	40.19	28.04	61.70	23.40	14.89	*0.0023

* $p < 0.05$.

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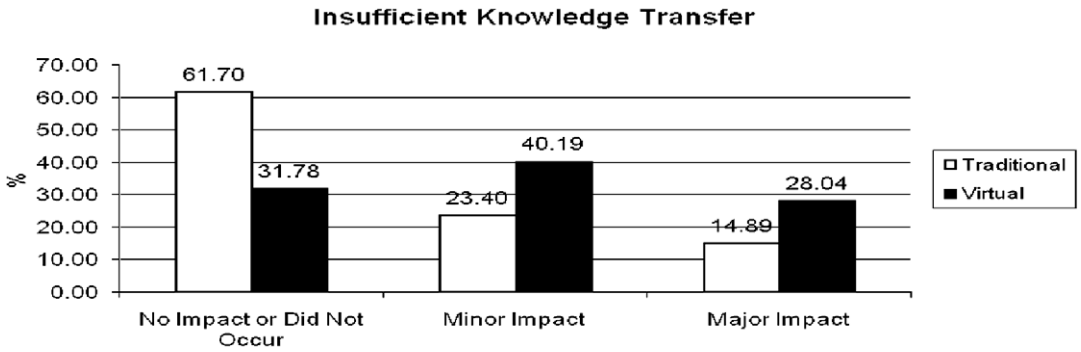

Fig. 1. Impact on project of insufficient knowledge transfer.

issues hindering communication did not have a significantly greater impact on virtual projects, thus causing us to reject our second hypothesis, H2. Only 15% of virtual project participants felt the impact of connectivity issues was major, while 53% felt the impact was minor. On co-located projects only 17% of participants felt the impact was major, while 49% felt the impact was minor. This low level of impact for both project types may have occurred because of three factors: the number of communication-related tools and their capabilities have increased, the number and severity of communication disruptions have declined, and the expertise to correct disruptions has expanded.

The participant response percentages to the third communication-related risk factor, *Insufficient knowledge transfer,* varied widely. Fig. 1 above shows the participant response percentages for each impact level and for both virtual and co-located projects.

The impact of insufficient knowledge transfer was significantly greater on virtual software projects than co-located software projects with a p-value well below 0.05 (0.0023), thus supporting hypothesis H3. Almost twice as many (62%) co-located project participants felt this risk factor either did not impact the project at all or did not occur on their projects. Only 32% of virtual project participants concurred with this view. This may be an indication that insufficient knowledge transfer is a non-issue on many co-located projects. Unlike the other two communication risk factors, where no significant differences were found between virtual and co-located project groups, the differences between the two groups for this risk factor are significant and support our original hypothesis, H3, that insufficient knowledge transfer does pose a significantly greater risk for projects using virtual teams than for those employing traditional co-located teams.

Knowledge transfer often centers on the sharing of expertise gained from years of experience (Choi and Kim, 2008). It is likely some of this information is implicit, i.e. it is not documented, but exists in the minds of seasoned employees. A common formal method of transferring knowledge is through cross-training or shadowing of an experienced employee through the use of face-to-face communication and meetings. This method is not very likely to occur on a virtual project. In addition, knowledge sharing on co-located projects that is implicit undoubtedly takes place informally, through water cooler or over-the-cubicle remarks. This type of casual knowledge sharing does not have a clear virtual equivalent. Consequently, sharing of undocumented knowledge and face-to-face exchange of information can be difficult to accomplish in a virtual environment. A possible solution is to convert more information into explicit knowledge and to emphasize documentation, which can then be exchanged electronically. However, this does not totally resolve the problem of the exchange of implicit knowledge, which will always exist and may in some cases, be just as important, or more important, than explicit knowledge.

5. Conclusion

We have demonstrated that there is a significant communication-related difference between projects employing traditional co-located teams and those using virtual teams, but that differences do not appear in all of the areas that have been suggested by prior research. Contrary to much conventional wisdom, there were no significant differences between co-located and virtual project teams on two communication-related risk factors: *inadequate communication* and *technological problems hindering communication*. Inadequate communication appears to be an important risk on projects of both types, while technological problems hindering communication does not appear to be a key risk for either type of project. The level playing field with respect to these two risks may in part reflect changes that have occurred over the years in the way projects are managed, including new tools and methods of communication and improvements in the technical aspects of electronic communication. Perhaps digital communications mitigate these communication-related risks similarly on both types of projects.

Insufficient knowledge transfer was found to have a significantly stronger negative impact on virtual software projects than on co-located software projects. A plausible explanation is an inability to transfer certain types of implicit knowledge or expertise successfully via electronic communication methods or without face-to-face

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communication. Knowledge transfer problems are exacerbated by the failure of the virtual environment to provide substantial opportunities to provide for the casual exchange of knowledge. We need further research on the specifics of differences in knowledge transfer between virtual and co-located project teams, as well as exploration of methods for enhancing implicit knowledge sharing on virtual projects. Additionally, future research is needed to investigate how levels of project risk vary with specific features of the knowledge being shared and its transfer process. While such research is in progress, managers of virtual projects should include the possibility of insufficient knowledge transfer in their risk management plans, and consider mitigating that risk to the extent possible by arranging to share knowledge electronically that would otherwise have been shared only implicitly.

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